SCIENCE

NEW SERIES
VOL. XLVIII No. 1241

FRIDAY, OCTOBER 11, 1918

SINGLE COPIES, 15 CTS.
ANNUAL SUBSCRIPTION, $5.00

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MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

A GEOMETRIC BASIS FOR PHYSICAL AND ORGANIC PHENOMENA

THE following notes refer to certain ideas which the writer has had in mind for many years, but in the form now submitted they are immediately suggested by a recent casual examination of D'Arcy W. Thompson's "Growth and Form" (Cambridge University Press, 1917) and particularly by reading certain paragraphs in this book relating to the various possible divisions of space by systems of surfaces or material films and membranes, in connection with a discussion of the internal structure of organic bodies.

A number of years ago the present writer submitted a brief paper to the American Physical Society under the title "A simple geometrical principle and its possible significance in connection with a general physical theory." The principle was stated as follows: "In any aggregation of an indefinite number of equal spherical bodies an arrangement giving minimum total volume occupied and perfect symmetry throughout is impossible." The quotations are from memory. An abstract of the paper was published at the time in the *Physical Review.*

Of course this principle might be dealt with by geometrical construction and mathematical analysis, but it can be demonstrated experimentally and in a simple and practical way by means of a number of balls of equal diameter like the hollow celluloid "ping-pong" balls, or the rubber balls sold as children's playthings. Thick mucilage, varnish, collodion, sealing wax or any other available adhesive substance may be used for sticking the balls together. Perhaps what follows may seem at first too elementary to be regarded as something of real scientific interest, but it is a matter of some surprise to find how many erroneous and confused ideas on so simple a

subject have been entertained and expressed even by scientific writers.

Place one of the balls on the table and arrange four others around and touching it with equal intervals between them in the form of a right-angled cross. Then place one ball directly on top of the central one, and finally one directly beneath it. This forms a group of seven balls which suggests one of the "jackstones" (generally made of iron or lead) that children play with. The group has a perfectly symmetrical arrangement which admits of indefinite extension on the same system in all directions by the addition of balls. In such a system any one ball, except of course those on the outer boundaries of the assemblage, is symmetrically surrounded by six others all touching the one that is central for this individual group of seven, but no two of these surrounding balls touch each other. The planes mutually tangent to each pair of balls at their common point of contact will obviously form by their intersections a system of equal cubes with common interfaces, each cube circumscribed about a ball. It is plain that these cubes "stack" together so as to make a solid volume, or in other words there will be no voids between—no waste of space. It will be clear that exactly the same arrangement results from placing on the table a number of balls in contact and in a single layer in "square" order, or with the balls in rows both ways at right angles like the squares on a checker board, and then placing another layer in the same formation with each ball directly over a ball of the first layer, and so on. The balls will have to be stuck together or very carefully placed or they will not retain this formation but they will fall down or spread and the pile will collapse under the influence of the gravitation of the earth.

It soon becomes apparent that this cubical arrangement is not the most compact possible or not the one which permits placing the greatest number of the balls in a given volume. For example, after placing the first layer in square formation greater concentration is attained by placing each ball of the second layer over an interval or space among the balls of each group of four in the first layer rather than directly over another ball, and so continuing the succeeding layers.

Now undertake to effect the most compact arrangement possible beginning with one ball, and place about a central ball on the table as many others of the same size as there is room for in one layer with all touching the central ball. There will of course be six side balls, all tangent to each other throughout as well as to the central ball, in hexagonal order. Then three more balls can be placed above touching the central one—and only three, though there are six intervals among the balls of the foundation layer—and likewise three others can be placed below, making twelve surrounding balls or a group of thirteen, all in mutual contact throughout, so that the position of each ball in the group is definitely fixed relative to its neighbors. This arrangement may be extended without limit and it is the most compact possible for an indefinite number of balls, but it is not perfectly symmetrical throughout. The mutually tangent planes at the points of tangency between the balls make a system of rhombic dodecahedrons, each one surrounding a ball. Equal rhombic dodecahedron will stack together without voids when similarly oriented but they do not form a completely symmetrical division of space, since the rhombic dodehedron is not one of the regular polyhedrons, or not a solid with all equal regular polygons for faces. All of the diedral angles of this solid are 120 degrees, but its twelve faces are equilateral oblique angled parallelograms or rhombs and the plane angles meeting at the vertices or solid angles are not therefore all equal.

It should be noted that the formation resulting from starting with a layer in square order and placing the balls of the next layer over the intervals in the first one and so on, is also this same rhombic dodecahedronal arrangement, only differently disposed with respect to the table or the horizontal plane. It is what we so often see in a pile of oranges in the groceries and on the fruit stands. In all horizontal layers of such a pile the balls are in square order, but there are other sys-

tems or series of layers in the pile, inclined to each other and to the horizontal, in which the balls are all in the hexagonal order, which is the closest assemblage possible in any one layer or plane.

We have thus developed one arrangement—the cubical—that gives universal symmetry with the balls in contact throughout, but not maximum concentration; and another one—the rhombic dodecahedral—that gives maximum concentration and density, but not universal symmetry. Now try for a formation that will give both.

The sphere is itself a shape of the most perfect symmetry and it has the very maximum quantity of contained volume or space for a given area of enclosing surface. It seems at first axiomatic and a foregone conclusion that an assemblage of equal spheres *must* admit of an arrangement or grouping that will give to the aggregate collection characteristics exactly similar to those of the individual sphere, with complete internal symmetry and equilibrium.

Recalling that in the second experiment the twelve side balls were placed about the central one all in mutual contact throughout so that the position of each ball in the group was definitely fixed and with no room for relative movement, it will perhaps be somewhat surprising to find that another arrangement for the twelve surounding balls is possible which gives a disposition perfectly symmetrical with respect to the central ball while the balls are nowhere in contact with each other at all, but each is equally and symmetrically spaced from all of its side neighbors. There is room to spare among the side balls but not enough for another ball. In this arangement the common tangent planes between the central and the surrounding balls form a regular polyhedron—the regular or pentagonal dodecahedron—about the central ball. This is a volume with twelve equal pentagons for faces, and of course having all its diedral angles as well as its vertices or polyhedral angles equal respectively. Each diedral angle of this solid, or the angle between any two adjacent faces, is 116° —34′ —54″; that is more than 90 degrees and somewhat less than 120 degrees, or between one quarter and one third of the complete angular space about one edge. Equal volumes or solids of this form may be assembled, face matching face, about a central one of the same size in a group of thirteen, but there must be a wedge shaped void, with a diedral angle at the edge of over ten degrees, between each two adjacent side members of the group where three edges of the solids coincide, and therefore the system can not be extended in the same formation by adding other equal solids of the same size and shape. From this it is apparent that a grouping of spheres inscribed in the equal regular dodecahedrons does not admit of this symmetrical arrangement beyond the group of thirteen.

(A compact grouping of eight equal spheres which is symmetrical with respect to a central point, not within any one of them, may also be arranged as follows: Place three of the spheres in contact on the table, with a fourth over the interval, making a triangular pyramid group or a regular tetrahedral grouping. Then place a sphere over each of the four spaces or openings that will be found over the outer surfaces of the group, each opening surrounded by three tangent spheres. The limit in number for this grouping is eight spheres—there is no available space for any more placed symmetrically—and here is a suggestion of possibly some relation to the "periodic law" of physical chemistry).

To summarize: The only possible arrangement or grouping of equal spheres in contact that gives perfect symmetry as a fixed condition throughout for a group of an indefinite number is the cubical system, and this does not give maximum density: while the only possible arrangement that gives maximum density as a fixed condition throughout such a group is the rhombic dodecahedral, but this does not give universal symmetry. *There is no arrangement possible giving both maximum density and universal symmetry.*

It is scarcely necessary to add that these relations in no manner depend on absolute dimensions—they are true for spheres of the

minutest diameter conceivable as well as for those of the most colossal size we can imagine, and for all intermediate sizes.

Now regard the spheres as equal masses of homogeneous matter endowed with the property of mutual attraction or gravity. They will tend to collect together in a group if free to move relatively, and to remain so. The cubical arrangement would be entirely consistent with complete equilibrium of the attracting forces, but this can not be permanent since it is not a formation of maximum density or concentration. It does not fully satisfy the collecting tendency under the forces of mutual attraction, and the equilibrium of the cubical formation must be unstable. If arranged on the cubical system the group will collapse on the slightest disturbance and the members will seek another arrangement permitting greater concentration. The rhombic dodecahedral grouping affords maximum concentration but it too fails to give complete stability, for it is not perfectly symmetrical and the forces of attraction can not be permanently balanced or in complete equilibrium throughout. Any one group of thirteen of the balls or spheres would be "satisfied" as to concentration and balance or equilibrium by the regular dodecahedral arrangement, but as above set forth this could not possibly obtain as a fixed condition throughout a group of more than thirteen of the spherical bodies. For a group of an indefinite number of the equal spheres greater than thirteen, *there is no stable and permanent arangement possible.*

We can now in imagination expand the diameter of the balls to any extent limited only by infinity—which means without limit—and likewise their size may be reduced to any dimensions short of zero, while their number may be multiplied also without restriction. The above relations are true for the smallest units of matter that can exist as well as for the most gigantic bodies. Furthermore the truth of these principles is not dependent on the complete *occupation by matter* of each of the individual spherical spaces or volumes considered. These spherical spaces may be only the respective "fields" or space loci of one or more separate portions of matter in a state of motion respecting neighboring portions in other similar spaces or fields—all having motions of revolution, of vibration, of oscillation, or of pulsation, with limitless combinations and variations as to size and number of the individual portions, their velocity, direction and amplitude of movement, etc.

Every assemblage or group of matter tends to assume the form with an external bounding surface of spherical shape under the mutual attractions of its parts, but however large or small such an assemblage or whatever may be the number of its individual members, its internal structure is governed by the principles above outlined. This indicates an explanation of the paradox involved in the first assumptions or impressions above referred to. The conceit that a perfectly symmetrical grouping of equal spheres with maximum concentration can be made, at first seemingly entirely simple and even axiomatic, turns out to be inconsistent with elementary facts of geometry and therefore impossible.

A direct corollary of this proposition is that a *plenum* of matter in any form, or any material "continuous medium," is impossible and non-existent. All material substances affected by gravity—which is equivalent to saying all real matter whatever—*must* be atomic or "granular" in its structure and in its behavior, and this does not depend upon an assumption of "intermolecular repulsion" or of "kinematical energy," nor indeed even upon the theory of energy as a separate entity, nor on any other extraordinary force or attribute. Plain gravitational attraction with the resultant unrelenting stress and struggle for a status which is *geometrically unattainable* is all-sufficient. This may even be made to account for apparent repulsion.

The reason for the conviction and belief that these principles have an intimate and fundamental relation to the universal and eternal unrest of matter and to all physical phenomena of whatever nature will now be apparent and we have at least an interesting and suggestive side light on Boltzmann's demonstration of "the indispensability of atom-

istics in natural philosophy," as recently referred to by Professor Bumstead.[1]

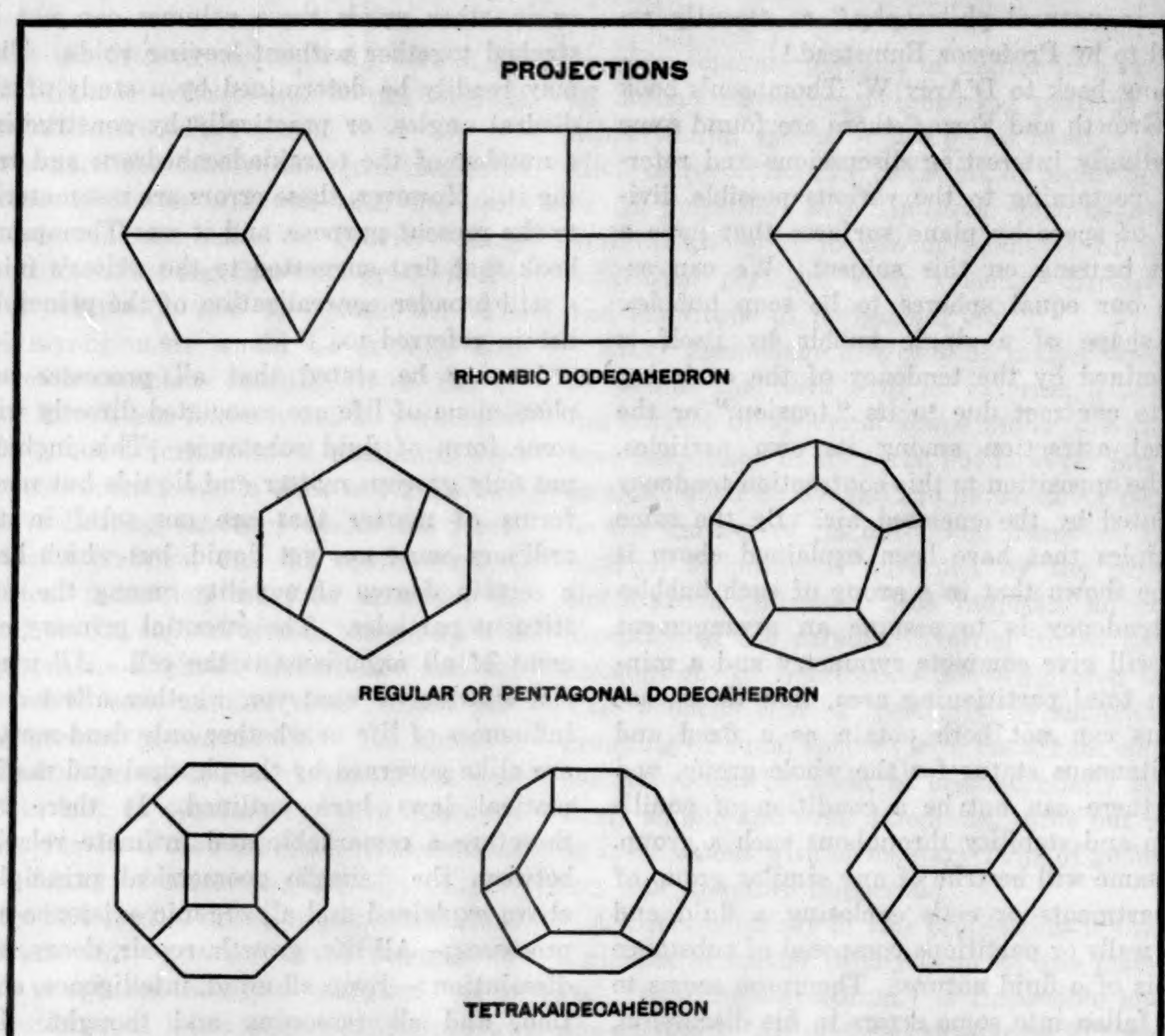
Going back to D'Arcy W. Thompson's book on "Growth and Form," there are found some exceedingly interesting discussions and references pertaining to the various possible divisions of space by plane surfaces that have a direct bearing on this subject. We can assume our equal spheres to be soap bubbles. The shape of a single bubble by itself is determined by the tendency of the enclosing film to contract due to its "tension," or the mutual attraction among its own particles, and the opposition to this contraction tendency presented by the enclosed air. By the same principles that have been explained above it can be shown that in a group of such bubbles the tendency is to assume an arrangement that will give complete symmetry and a minimum total partitioning area, that these conditions can not both obtain as a fixed and simultaneous status for the whole group, and that there can not be a condition of equilibrium and stability throughout such a group. The same will be true of any similar group of compartments or cells enclosing a fluid and with walls or partitions composed of substance that is of a fluid nature. Thompson seems to have fallen into some errors in his discussion, as where he calls the rhombic dodecahedron a "regular solid"[2] and where he understands that by means of an assemblage of equal and similar "tetrakiadecahedrons" space may be homogeneously partitioned into similar and similarly situated cells "with an economy of surface in relation to area (volume ?) even greater than in an assemblage of rhombic dodecahedra" (p. 338). The "regular" tetrakiadecahedron is a semi-regular polyhedron, a fourteen-sided volume with six equal square faces and eight that are regular and equal hexagons, the sides of these squares and hexagons all being equal. Such a solid may be formed by cutting off the corners of a cube, also by cutting off the corners of a regular octahedron. Space can not be divided into equal volumes of this shape without surplus, or in other words these volumes can not be stacked together without leaving voids. This may readily be determined by a study of the diedral angles, or practically by constructing a number of the tetrakiadecahedrons and trying it. However, these errors are not material to the present purpose, and it was Thompson's book that first suggested to the writer's mind a still broader generalization of the principles herein referred to.

It may be stated that all processes and phenomena of life are associated directly with some form of fluid substance. This includes not only gaseous matter and liquids but many forms of matter that are not solid in the ordinary sense nor yet liquid, but which have a certain degree of mobility among the constituent particles. The essential primary element of all organisms is the cell. *All* material substances whatever, whether affected by influences of life or whether only dead matter, are alike governed by the physical and mathematical laws here outlined. Is there not therefore a remarkable and intimate relation between the "simple geometrical principle" above explained and all organic existence and processes;—All life, growth, repair, decay, and dissolution:—Even all mind, intelligence, emotion, and all reasoning and thought. The speculative philosopher might indeed go so far as to add all health, satisfaction, and pleasure; all sickness, distress and pain; all relations and struggles among humans, all endeavors of man, all events of history, *everything:*—And the psychologist may here note an analogy to the unending strife between good and evil which figures in so many of man's superstitions and religious beliefs, primitive and otherwise.

A further conception of the profound significance of these elementary geometrical relations in connection with all activities and phenomena of the material universe may be formed by imaging a region or space, apart from any known real one, where it *is* possible for equal spheres to be so grouped that the arrangement will have at the same time maximum concentration and universal symmetry—an imaginary space where the regular dodeca-

[1] See Science for January 18, 1918.

[2] "Growth and Form," p. 328.



To accompany paper on "A Geometrical Basis for Physical and Organic Phenomena" by John Mills

Drawn by O. W. Robeson

hedron has each of its diedral angles exactly 120 degrees instead of 116° —33′ —54″ (or, if preferred, where the full circle is made up of about 349—2/3 real degrees instead of 360), and where equal solids of this form will therefore stack together without voids. The curious and interesting speculations and deductions that follow from imagining a space with more dimensions than real space possesses (as four dimension or *n* dimension space), or a space having special properties like "curvature," etc., are quite well known. All matter in the hypothetical space permitting the special arrangement of equal spheres as above will, if we assume gravity to remain normal, tend to concentration as in real space but this tendency will not be checked or modified or counteracted by a departure from equilibrium resulting from an approach or approximation to the rhombic dodecahedral grouping of spherical elements, since the tendency will be to assume the regular dodecahedral grouping throughout. All matter under these conditions must eventually become a stagnant and dead plenum, an amorphous and non granular mass, in which no physical activity or life could possibly have being.

Another curious paradox, not altogether devoid of usefulness, is found in the self contradictory conception, which is at least semi logical, that there could only be a "real" continuous *ether* in a space with the imaginary properties above described! There are as yet unsurmounted (and unsurmountable?) diffi-

culties in the way of attempts at such a conception for *real* space, but even in the hypothetical space a continuous ether would find obstacles to the exercise of its principal function which is "to undulate." Moreover there would be no particular object in undulating—nothing to incite undulation—and so from all angles the ether idea has a rather hard struggle for a real existence.

We deduce properties of the circle by assuming that it is possible to divide the continuously curved circumference into parts so small that each one will be a straight line, and the rigid accuracy of the results so obtained is in no degree vitiated by the fact that the assumption can not possibly be true. Likewise we may deal with physical phenomena *as though there were* a "medium," an all pervading plenum of substance, itself devoid of gravity and of most other properties of real matter saving only the capacity to undulate. We can deduce, explain and predict with entire success—with consistent results and even astonishing confirmations—notwithstanding our medium or ether may be entirely hypothetical, its assumed properties may be contradictory in themselves, and it may not be possible for such an imaginary medium to have a real objective existence.

To locate and corner the remaining major difficulty in the way of a full comprehension of things of nature will at least contribute to our plans and measures for mobilization of forces and will indicate the main objective and the methods of attack, even if the adversary shall prove forever invincible.

Body B is separated from body A by an intervening distance. It is not possible for an "impulse" of mutual influence which requires time for the passage to be in transit between A and B, to be disconnected from both for the moment—suspended between them in other words—*without any intervening medium except space?* What a flood of light and clarity would be shed on and through the accumulated mass of physical facts and data, as well as the tangled maze of speculative perplexities, if an affirmative answer to this conundrum could only be given.

No confession of individual faith can be claimed to be of itself a useful contribution to our knowledge of material things, and this is distinctly true so far as concerns the ideas of the undersigned, but as has recently been said by a distinguished physicist it is well sometimes to declare ourselves in this respect "for this naturally has its influence upon all that is said and done and to the end of making the point of view of the writer clearly understood." (Crehore) It will be advantageous for the reader if he can feel that the writer is setting forth ideas with a certain degree of self felt confidence and "intellectual rest." I will therefore add the following, which is stated partly in the first person since it is a sort of individually conceived framework or background on which to pin ideas and new facts; frequently with a satisfactory fit in place, sometimes for the moment quite detached from the general pattern, but as a rule with a constant tendency towards accordance with what may ultimately turn out to be a complete and consistent picture.

There is only one kind of real space, the kind of everyday experience.

There is no material substance that does not have the common attribute of gravity.

There is no "force" except gravity, and all physical phenomena are resolvable into this conception.

Gravity is an inherent, essential, and universal attribute of matter. It is and ever will remain inexplainable. What is more (and this is another paradox) if an "explanation" were possible this would actually be a retrograde step in the progress of knowledge, since we would then have at least one remaining mystery on our hands, almost certainly still more troublesome than is that of gravity.

There is no such real thing as a continuous medium or ether. This however in no manner or degree disparages the vast majority of the facts, results and predictions that have been accumulated and accomplished on the "as though there were" assumption regarding an ether, nor is it inconsistent with the confident belief that there will be very many additional real and useful developments and advances in

our knowledge of natural things and phenomena on the same assumption.

It will be recognized that whatever there may be of novelty in the above first principles is found in the combination rather than in any one element.

Finally I concede with the eminent philosophers of long ago that an idea of the real nature of "action at a distance" without any intervening medium is inconceivable to the human mind (*my* human mind—they no doubt likewise meant theirs) and especially so is the suggestion that an impulse which requires time for transmission from one body to another may have left the one and be on the way to the other—in a state of detachment between—with nothing but empty space along the road. (It is probable that the "velocity of light" as a physical constant is the same as the velocity of transmission of a gravitational impulse or change from one body of matter to another, or at least that there is some very direct relation beween the two.)

Here however is the parting of the ways. I have faith that it will some day be accepted that this inconceivableness is attributable, *not* to the fact that the suggestion is incompatible with the real workings of nature, but to the limitations in the powers of human comprehension.

If it can be accepted that "philosophy" is only a shorter term for peace of mind arrived at or approximated to after long pondering, then the above may be set down as a sort of personal philosophy of the writer's.

And the path of future progress? We are apt to regard the human intellect of our period as already in a stage of its development which may be called maturity, but this is not at all certain. If something like a curve is plotted to indicate the mental status of man at different periods or "ages"—the primitive state, the stone age, the bronze age, the age of iron, etc., its general shape will indicate whether the present is the age of finality in this respect. There was just as much reason for regarding any one of the previous ages as a culmination as there is for assuming that we are now on an ultimate crest of the curve of human powers of understanding. In fact if we consider the varying rate of change in direction of such a curve, or the rate of its departure from a base line of zero intelligence, there is less ground for thinking our present mental capacity is at a maximum than there was for such a belief at any previous age or period.

Let us therefore "play" that there *is* an ether, with all its seemingly necessary though improbable attributes, and go ahead with our observations, experiments, studies and researches until the mind of man, now possibly only in the juvenile or youthful stage of its growth, may have so far advanced towards maturity as to be able to put aside this elementary conception and to substitute something more grown up. Meanwhile let us not lose sight of this all-important coordinate part of the program for advancing—the development of the human mind in capacity for comprehension so it can assimilate and interpret the facts as they accumulate and keep pace with the general progress. The super intelligence capable of fully comprehending all nature will doubtless always remain a limiting ideal—something to be eternally striven for, to be approached all the while more nearly, but forever unattainable.

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SCIENTIFIC EVENTS

MANGANESE ORE IN GEORGIA

As manganese is urgently needed in the war several geologists of the United States Geological Survey, Department of the Interior, have been making systematic examinations of areas that are believed to contain deposits of manganese and manganiferous ores in the United States and the West Indies, in order to appraise our available resources of manganese and to assist in stimulating its production and use.

Manganese is a metal resembling iron. It is used principally in the manufacture of steel, to which it is added in the form of alloys with iron, such as ferromanganese and spiegeleisen. It is used also in glassmaking, in many chem-

ical industries, and in the manufacture of electric batteries. There are four commercial sources of manganese—manganese ores, manganiferous iron ores, manganiferous silver ores and manganiferous residuum from roasting zinc from an ore containing zinc, iron and manganese minerals. Under normal conditions the world's supply of manganese ore has come mainly from India, Brazil and Russia, but owing to the derangement of ocean transportation and of the foreign manganese industry only the deposits of Brazil are now available to the United States, and these can not be drawn upon freely because of the scarcity of ships and the long shipment.

The deposits of manganese ore in the Cartersville district, Ga., have recently been examined by Laurence LaForge, geologist of the United States Geological Survey, Department of the Interior, in cooperation with Mr. J. P. D. Hull, assistant state geologist of Georgia, and Professor W. R. Crane, of the United States Bureau of Mines. The ore deposits occur in a belt, 1 to 3 miles wide and 18 miles long, on the east side of the Coosa Valley, at the base of and on the western slopes of the hills that form the western margin of the Piedmont Plateau. This belt is in the eastern part of Bartow county, and the city of Cartersville is on its west side near its south end A branch of the Louisville & Nashville Railroad extends along the west side of the belt and spur tracks reach several of the larger mines. Iron ore, ocher and barite are also mined in this belt, and some of the mines produce two or more of these minerals.

The result of the examination is encouraging, for, although the district is an old one, the field studies of the geologists and the exploratory work of the mining companies have revealed the existence in it of large reserves of both high-grade manganese ore and manganiferous iron ore. In recent years little manganese ore has been mined in this district, but the necessity of the war and the curtailment of imports which have stimulated the production of domestic ore have caused a revival of mining there.

The workable manganese ores occur in part in vein and replacement deposits and in part in detrital deposits. The ores in the vein and replacement deposits are believed to have been deposited from surface water that carried in solution material leached from a considerable thickness of weathered rock, or, in places, from other older deposits of the same sort. The detrital deposits are scattered through a widespread thick surficial mantle of rock waste, wash and alluvium. The deposits of both types are extremely irregular in character and occurrence. They include both hard and soft ore and both pyrolusite and psilomelane, and perhaps manganite, though pyrolusite seems to be more abundant. Both types include large bodies of manganiferous limonite.

The vein and replacement deposits are found mainly in residual clay and fragments of rock derived by weathering from a siliceous limestone, or in a breccia made up chiefly of the shattered, weathered and somewhat displaced upper beds of quartzite that lies beneath the limestone. Some, however, are found at or near the base of the thick surficial blanket of rock waste and alluvium, in which detrital ores also occur. The manganese minerals occur as coatings on or as veins filling crevices in the quartzite; as irregular veins, sheets and pockets in both residual clay and alluvial material; and as stalactitic or mammillary concretions in the clay.

The hard rock that underlies most of the vein and replacement deposits is the Weisner quartzite, which was once overlain by the limestone that has been called the Beaver limestone, both Lower Cambrian formations. Beds of siliceous dolomite still remain, but nearly everywhere the soluble material of the limestone has been removed and nothing is left to indicate its former presence but a dense lumpy dark-red clay or masses of chert fragments in a red clay matrix. The strata have been sharply folded and have been displaced by many small thrust faults, so that the resulting structure is very complex.

The high-grade ore of the Cartersville district, as shown by the average of analyses of about 1,600 tons of material shipped within the last few months, contains about 42 per

cent. of manganese, 6 per cent. of iron, 6 per cent. of silica and 0.14 to 0.20 per cent. ot phosphorus. The manganiferous iron ore of the district, as shown by the average of the analyses of about 30υ tons shipped recently, contains about 15 per cent. of manganese, 20 per cent. of iron, 30 per cent. of insoluble material and 0.17 per cent. of phosphorus. Practically all the ore produced in the district is shipped to furnaces at Birmingham, Ala., for the manufacture of ferromanganese, spiegeleisen and manganiferous pig iron.

The irregularity of the occurrence of the ores, the complex geologic structure, and the scarcity of outcrops in much of the district make it extremely difficult to use the geologic conditions as a guide in exploration and development and hazardous to predict the probable occurrence of ore in any locality or to do much more than to guess at the reserves of ore. Fortunately, however, the district has been worked for many years, either for manganese ore or for other minerals, and has been rather thoroughly explored, so that there is some basis for an estimate of the reserves. The statement seems to be warranted that the district probably still contains at least 100,000 tons of minable high-grade manganese ore and perhaps 250,000 to 300,000 tons of manganiferous iron ore—sufficient to last for many years unless the rate of production is greatly increased.

BRITISH ELECTRICAL INDUSTRIES AFTER THE WAR

In the general survey with which the report of the British Departmental Committee on the electrical trades is introduced, it is urged, as we learn from the *Journal* of the Society of Arts, that the national importance of those trades has never been realized either by the government or the general public. Through the achievements of Faraday, Wheatstone, Kelvin, Swan, Hopkinson, and many others, Great Britain was first in electrical enterprise, and should have retained her preeminence; but manufacturers were hampered while Parliament and local authorities debated how the distribution and use of electricity might be prevented from infringing "conventional conceptions of public privileges and vested interests." Consequently foreign manufacturers were enabled, both in their own and other markets to gain a hold which they have never lost. The approximate annual value before the war of the total products of electrical plant, mains, and appliances in this country and Germany is set out in the following table:

	Great Britain, £	Germany, £
Total electrical products.	22,500,000	60,000,000
Exports	7,500,000	15,000,000
Imports	2,933,000	631,000
Consumption of home-made machinery	15,000,000	45,000,000

Moreover, of the £22,500,000 manufactured here, a large proportion was produced by concerns under foreign control, and in the case of "British" exports a proportion consisted of foreign manufactures reshipped as British goods! Apart from legislative obstacles, Great Britain, it must be remembered, had attained much prosperity and technical efficiency in her use of steam, and therefore her manufacturers had less inducement than their rivals in foreign countries to adopt electrical driving. Another factor retarding our electrical progress has been the "strength of the gas interests." Again, foreign governments, appreciating the importance of conserving their home markets as a basis for the development of overseas trade, imposed protective duties and exerted influence on State Departments to purchase native goods. An industry cultivated under these and other encouraging conditions has had an immense advantage in international competition. There is, the committee says, conclusive evidence of the existence of German control over companies ostensibly British, and of that German control being exercised to the detriment of British interests indirectly through companies incorporated in America, Switzerland, and other neutral countries. "At the outbreak of war negotiations were in progress for the acquisition by Germany of financial control in existing companies of the United Kingdom, as well as in the British Dominions and India,

which if successfully concluded would have still further restricted the use of British goods in many parts of the empire."

The scientific replanning of our distribution of energy on which the committee so strongly insists would, it is calculated, effect a saving of no less than 50 million tons of coal per annum. Witnesses of high authority estimate the loss incurred by the nation through failure to take full advantage of electrical progress at quite £100,000,000 a year.

The larger part of the report is devoted to a careful and detailed examination, from sectional points of view, of the position of the industry. Section I. deals with electricity generation and transmission; Section II. with electrical traction; Section III. with manufacturing; Section IV. with the interdependence of manufacture and finance; and Section V. with imperial control of sources of electrical energy. Respecting the latter, it is suggested that, in particular, India and the self-governing Dominions should take stock of their facilities for generating electricity, whether from water-power, coal, oil, or other sources of energy, and should appreciate their permanent and ever-increasing importance to the empire.

THE DEPARTMENT OF CHEMISTRY OF THE COLLEGE OF THE CITY OF NEW YORK

The following members of the staff of the department of chemistry have gone into war work:

1. In the service:

Captain Reston Stevenson, Sanitary Corps, Overseas.

Major F. E. Breithut, Chief Personnel Officer, Chemical Warfare Service.

Second Lieutenant Paul Gross, Research Division, Chemical Warfare Service.

Captain D. L. Williams, chief of supplies, Research Division, Chemical Warfare Service.

Second Lieutenant Martin Meyer, United States Army.

Corporal Howard Adler, Chemical Warfare Service.

Corporal Arthur W. Davidson, Chemical Warfare Service.

Ensign Benjamin Rayved, Paymaster Division.

Private Leon J. Smolen.

Private Nathan Rauch, Chemical Warfare Service.

Private Moses Chertcoff, Chemical Warfare Service.

Private F. L. Weber, Students' Army Training Corps.

Private Martin Kilpatrick, Chemical Warfare Service.

Private Hyman Storch, Chemical Warfare Service.

Joseph L. Guinane, Chemical Warfare Service.

Private Samuel Yachnowitz.

Yeoman Julius Leonard.

Yeoman Alexander Lehrman, Chemical Division.

2. In civilian capacity:

Professor H. R. Moody, War Industries Board.

Tutor B. G. Feinberg, Ordnance.

Fellow Paul Scherer, Ordnance.

The present staff is as follows:

Baskerville, Charles, professor and director of the Chemistry Building, emeritus.

Friedburg, L. H., associate professor of chemistry.

Curtman, Louis J., assistant professor, chief of the Division of Qualitative Chemistry.

Prager, William L., assistant professor, chief of the Division of Organic Chemistry.

Curtis, Robert W., assistant professor, chief of the Division of Quantitative Chemistry.

Estabrooke, William L., assistant professor, chief of the Division of the Evening and Summer Sessions.

Coles, Henry T., assistant professor of industrial chemistry.

Cooper, Herman C., assistant professor of physical chemistry.

McCrosky, Carl R., instructor.

LeCompte, T. R., instructor.

Brown, Stanley F., tutor.

Meltsner, Max, tutor.

Babor, Joseph A., tutor.

THE CHEMICAL WARFARE SERVICE

The Chemical Warfare Service has been duly authorized by order of the Secretary of War, to make the necessary arrangements through the Adjutant General's Office to secure the furlough, without pay or allowances, of such chemists as are necessary in such government bureaus as the Bureau of Standards, Bureau of Chemistry, Bureau of Mines, United States Patent Office, where such chem-

ists are engaged in chemical work for the government, or state bureaus concerned, essential to the prosecution of the war. At the same time they are advised that the new selective service regulations, to be published shortly, will emphasize to the draft boards the fact that skilled employees of war industries should be placed in deferred classification. The induction into the military service of skilled men necessary to essential industries or occupations, to be subsequently furloughed back to their industries or occupations, involves an expense to the government, and the men concerned lose time from their necessary work. The bureaus concerned are authorized by the selective service regulations to submit to the draft boards affidavits and written proof to maintain their contention that their employees should be placed in deferred classification and it is believed that they should be encouraged in securing deferred classification rather than securing the furlough of the men after they have been inducted into the military service. All communications in regard to information from those desiring any details should be addressed to Major Victor Lenher, Chemical Warfare Service, U. S. A., chief, governmental and State Relations Branch, Unit F, Corridor 3, Floor 3, 7th and B Streets, N.W., Washington, D. C.

THE AMERICAN COLLEGE OF SURGEONS

THE American College of Surgeons will convene at the Waldorf-Astoria Hotel, New York City on October 21. Arrangements for the meeting, which is expected to attract surgeons from all parts of the United States and Canada, are in charge of a committee headed by Dr. J. Bentley Squier. Three important meetings at which the latest discoveries in medical science will be discussed and demonstrated will be held on October 22, 23 and 24.

The first will be addressed by the retiring president, Dr. John G. Clark, of Philadelphia, after which Dr. William J. Mayo, of Rochester, Minn., president-elect, will be inducted into office. Other speakers at this meeting will be Surgeon-General Gorgas, of the army, Surgeon-General Braisted, of the navy, and Surgeon-General Victor Blue, of the public health service. Clinics will feature the remaining sessions.

Among the surgeons expected from abroad are Sir Thomas Myles, C.B., of Dublin; Gray Turner, of Newcastle-on-Tyne; Raffaele Bastianelli, of Italy; Major R. Ledeaux Lebard, of the French army; Theodore Tuffler, Surgeon-General of the French army; Lieutenant Colonel Clarence L. Starr, of Toronto; Sir Robert Jones, of Liverpool; W. W. Chipman, of Montreal; Pierre Duvall, of Paris; Surgeon-General Antoine de Page, of the Belgian army, and Colonel Cuthbert Wallace, of the British army.

Prominent American surgeons who are expected to attend are Major-General M. W. Ireland; Surgeon-General Blue, of the public health service; Major General Gorgas, of the army; Surgeon-General Braisted, of the navy; Colonel Frank Billings and Colonel Joseph Miller, of the Army Medical Corps, and Dr. Frank Martin, founder of the American College of Surgeons. An invitation has also been sent to Colonel Joseph A. Blake and Colonel George E. Brewer, New York surgeons, now with the forces in France.

THE AMERICAN AGRICULTURAL COMMITTEE

THE United States Department of Agriculture announces the arrival in England of a committee of men familiar with food production and agricultural organization and activities in the United States. The personnel of the committee is as follows:

Dr. W. O. Thompson, chairman, president of Ohio State University, Columbus, Ohio; Mr. Carl Vrooman, Assistant Secretary of Agriculture; Mr. R. A. Pearson, president of Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa; Mr. T. F. Hunt, director of the Agricultural Experiment Station and dean of the College of Agriculture, University of California, Berkeley, Cal.; Mr. D. R. Coker, farmer and member of National Agricultural Advisory Committee, Hartsville, S. C.; Mr. Wm. A. Taylor, chief, Bureau of Plant Industry, U. S. Department of Agriculture; Mr. George M. Rommel, chief,

Animal Husbandry Division, Bureau of Animal Industry, U. S. Department of Agriculture; Mr. George R. Argo, specialist in cotton business methods, Bureau of Markets, U. S. Department of Agriculture; Mr. John F. Wilmeth, administrative assistant, Bureau of Markets, U. S. Department of Agriculture.

The committee will secure general information regarding food production conditions in England, France and Italy, so that, when they return, they will be able to reveal the needs more effectively to the leaders of agriculture in the United States and to farmers generally. They will also study agricultural problems in England, France and Italy, including the use of machinery and the assignment of labor in farming operations, the livestock situation, the depletion of herds and the probable extent to which Europe may call on this country for live stock to replenish herds, the seed situation and the probabilities of securing supplies from Europe and similar matters.

SCIENTIFIC NOTES AND NEWS

MAJOR GENERAL MERRITTE W. IRELAND, of the Medical Corps, has been appointed Surgeon General of the Army, to succeed Major William C. Gorgas, who was retired on October 5. General Gorgas will remain in Europe as the medical representative of the United States Army at the Interallied War Council.

DR. ARTHUR L. DAY, director of the Geophysical Laboratory of the Carnegie Institution of Washington since its establishment in 1906, has resigned to accept a research position with the Corning Glass Works, Corning, N. Y.

SECRETARY HOUSTON has visited the drought-strickened sections of the country to confer with field representatives of the Department of Agriculture in regard to making loans to farmers from the special fund of $5,000,000 set aside for that purpose. Professor G. I. Christie and Mr. L. M. Estabrook, assistants to the Secretary, are supervising the work in the northwest and southwest, respectively.

PROFESSOR FRANK P. UNDERHILL, of Yale University, has received the commission of Lieutenant Colonel in the Chemical Warfare Service. He is in charge of gas investigations at New Haven.

WILLIAM H. ROSS, of the Bureau of Soils, has been commissioned captain in the Chemical Warfare Service and has been assigned to work in the chemical laboratory, at Edgewood Arsenal in Maryland.

DR. LUCIUS POLK BROWN, chief of the Bureau of Food and Drugs of the New York City Health Department, has been granted leave of absence without salary for the period of the war, to accept a commission as a captain in the food and nutrition division of the sanitary corps.

DR. PAUL E. KLOPSTEG, formerly of the physics department of the University of Minnesota, is now with the Leeds and Northrup Company, of Philadelphia.

THE Italian Scientific Society has awarded the natural sciences gold medal for 1918 to Professor Filippo Eredia for his work in meteorology.

IN honor of Professor Golgi, who retires this year from the chair of pathology and histology at the University of Pavia, it is proposed to found a scholarship in the medical department for the orphan of some physician, preferably one whose father was lost during the present war. Contributions may be sent to the treasurer, Tesoriere dell' Ordine dei Medici della Provincia di Pavia.

MR. WILLIAM BOWIE has resigned as treasurer of the Washington Academy of Sciences on account of having been commissioned a major in the Engineering Corps, U. S. A., and is succeeded by Mr. R. L. Faris, of the Coast and Geodetic Survey.

MR. GEO. F. FREEMAN, plant breeder in the college of agriculture of the University of Arizona, has left for Egypt and will take up his permanent residence in Cairo, in connection with the Société Sultanienne de Agriculture.

THE first lecture of the series of the Harvey Society will be given in New York City on Oc-

tober 19, at 8.30 P.M., by Dr. E. K. Dunham, on "Certain aspects of the application of antiseptics in military practise."

Professor Edward F. Northrup, of Princeton University, addressed the meeting of the Institute of Radio Engineers on October 9, on the subject "Special heating effects of radio frequency currents."

Dr. Charles R. Eastman, of the American Museum of Natural History, the author of important contributions to paleichthyology, was drowned at Long Beach on September 27.

By the will of Alfred Louis Moreau Gottschalk, American Consul General at Rio de Janeiro, Brazil, who was one of the passengers on the United States collier *Cyclops*, which mysteriously disappeared from the seas last March, the U. S. National Museum receives a valuable collection of Inca pottery, Aztec idols, Trojan lamps, eastern brasses and arms, pottery and porcelains from Spanish America.

Brazil is sending a medical mission to France. The party is to consist of fifty doctors besides a number of students. They are to be attached to the Brazilian Hospital already installed near the front.

Twelve professors chosen from the faculties of various Spanish universities spent August in Paris, visiting the principal medical and surgical centers. The mission was charged to prepare a report on the progress made by French war surgery.

The much-dreaded European potato wart disease for which the Federal Horticultural Board quarantined against further importation of potatoes in September, 1912, has been discovered in ten mining villages near Hazleton, Pa., by Professor J. G. Sanders, economic zoologist of that state. Every effort of the state authorities, with the federal department assisting, is being directed to prevent the further spread of this insidious and most dangerous disease known to affect the potato. It appears that the disease has been established in some of these villages for at least seven or eight years, where it has been impossible to secure even the amount of seed planted in some gardens for the past few years. Only by accident was this disease discovered in these villages, which are largely made up of foreigners, who supposed that there was something affecting the soil and ruining the crop. It seems advisable that all state authorities should inspect large centers of consumption where imported potatoes may have been purchased during the past eight or ten years.

The British Ministry of Munitions has made an order prohibiting the sale, except under licence, of radio-active substances, luminous bodies and ores. The order applies to all radio-active substances (including actinium, radium, uranium, thorium and their disintegration products and compounds), luminous bodies in the preparation of which any radio-active substance is used, and ores from which any radio-active substance is obtainable, except uranium nitrate and except radio-active substances at the date of the order forming an integral part of an instrument, including instruments of precision or for timekeeping.

Mr. J. E. Barnard, speaking at the British Scientific Products Exhibition at King's College on August 20, said that the microscope was the almost universal tool of scientists, and was used in every industry which had a technical side. There was little doubt that after the war the microscope industry would undergo a transformation that would lead to a state of affairs in which the British microscope would be preeminent, as indeed, it was somewhere about 1880 to 1890.

Some of the results of research on the nitrogen problem were shown at the British Scientific Products Exhibition at King's College, London. The Munitions Inventions Department of the Ministry of Munitions exhibited a unit plant for the oxidation of ammonia to oxides of nitrogen. The process (which was not extensively used outside Germany before the war) has been largely used by the enemy to obtain nitric acid for explosives, and also in the manufacture of sulphuric acid by the chamber process as a substitute for Chile nitrate, which he has been unable to obtain owing to the blockade. The method is now widely used in England, and large firms,

such as Messrs. Brunner, Mond, and Co. (Limited), and the United Alkali Company (Limited), are using apparatus similar to that exhibited. The program of lectures at the exhibition was as follows: Professor A. Keith, F.R.S., "Scientific progress as applied to medicine." Dr. F. M. Perkin, "Oils from mineral sources." Mr. R. E. Dennett, "Palm tree to margarine factory." Mr. A. Newlands, "Water power in industry." Dr. C. H. Browning, "Advances in bacteriology in peace and war" (lantern lecture).

The Electrical Review, London, states that the results of the first two thrashings of electrified corn are announced by Mr. H. H. Dunn, seed specialist, of Salisbury. In the *Daily Mail* last July it was stated that over 2,000 acres were then under electrified seed. The electrification consists of soaking the seed in a weak solution of common salt or calcium chloride, passing a comparatively small electric current through the grain in soak for a few hours, and then slowly drying it in a kiln. Wheat grown at Fort St. Cleer, Liskeard, Cornwall, showed 28 per cent. increase on grain and 40 per cent. on straw. Oats grown at Moreton, near Dorchester, showed a gain of 61 per cent. on grain.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of the late Elmer P. Howe, '76, whose death occurred on June 13, 1918, Yale University would receive one half of the residuary estate, its share being estimated at about $200,000. An equal amount will go to the Worcester Polytechnic Institute.

MAJOR GEORGE W. LITTLEFIELD, of Austin, has loaned the University of Texas, of which he is a regent, $800,000. In addition to this sum he purchased the famous Wrenn private library of its Chicago owners last spring for $225,000 and has donated the collection to the university. He also gave as a gift $5,000 for fitting up a room at the university in which to place the library. The $800,000 which he has loaned to the institution is being expended in building additions to the war schools which the university is conducting for the government. These schools include automobile mechanics, radio, aviation and military aeronautics.

The Experimental Station Record states that the agricultural school and experiment station near Panama City, Panama, started in 1915, has been closed for lack of funds. Dr. B. H. A. Groth, formerly of the New Jersey Station, who has been in charge of the school and station since its establishment, has returned to this country.

THE corporation of McGill University has formally approved a recommendation made by the faculty of medicine, that women should be admitted to the study of medicine provided they have completed the first and second years in arts at McGill University, have taken an arts degree from a recognized university, or are prepared to take the double course of B.A. and M.D. or B.Sc. and M.D. at McGill. Women students are now admitted also to the medical faculties of Toronto, Queen's, and the Western Universities.

DR. WILLIAM E. KELLICOTT, professor of biology in Goucher College and recently head of the report division of the United States Food Administration, has been appointed professor of biology and chairman of the department in the College of the City of New York.

R. V. MITCHELL, professor of poultry at Delaware Colege, has been elected head of the poultry department, and director of the all northwest egg laying contest at the State College of Washington, Pullman, Washington.

DR. V. H. YOUNG, formerly assistant professor of botany at the State University of Iowa, who was appointed assistant pathologist in the Office of Cotton, Truck and Forage Crop Disease Investigations of the U. S. Bureau of Plant Industry at the close of the last school year, has now resigned from this position to become professor of botany and head of the department of botany at the University of Idaho.

DISCUSSION AND CORRESPONDENCE

ERRONEOUS GENERIC DETERMINATIONS OF BEES

The history of almost any considerable group will show that a subgenus is only a suppressed genus. In an introduction to Wilson's "American Ornithology," 1852, T. M. Brewer makes the following statement which gives an anachronistic setting to recent protests:

I have also judged it inexpedient to imitate the needless subdivisions into genera, which is the prevailing fault in modern ornithology. Without entering into a discussion of this controverted question, I have only to urge, in defense of my adhesion except in such instances as it appeared to be wrong to do so, to old genera—my conviction that the present mode of subdivision, instead of tending to simplify science, as its advocates assert, but adds to the difficulties of the beginner, and serves to discourage his efforts to master the subject.

In a synopsis at the end of this work, for example, all of the hawks and eagles are referred to *Falco* and the owls to *Strix*. The subgenera mentioned there are now recognized as genera and some of them have been subdivided into genera.

Primitive people, ignorant and stupid people, old fogies and beginners prefer large genera. But of all the people who use language the taxonomists known as "lumpers" are the only ones ever known to object to the formation of categories. A new genus is like vice, "a monster of so frightful mein." It is first an "alleged genus," then a subgenus, then a genus. In a large genus, if you can distinguish a group of species by any distinct characters, name the group. If you only point out the characters, some one else will name your group for you. In 1802 Kirby subdivided the bees into *Apis* and *Melitta,* but he separated them into many groups, not named but designated by signs. In the same year, and later, Latreille hamed many genera which were practically identical with the groups distinguished by Kirby. Since that time students of bees have been slow to take Kirby as a warning and Latreille as an example.

Confusion regarding genera results from the efforts of conservatives to force the conceptions associated with the theory of special creation upon those who accept the scientific theory of evolution. Under the former view genera were originally distinct. Under the latter view they were originally connected by transitional forms. The most distinct genera occur in old groups which have been broken into widely separated fragments by a process of extinction which has destroyed most of the original forms. The transitional form may be one of several things, but suppression of a genus on account of it usually involves an argument based on exceptions. If two genera containing many species could be separated all over the world, the lumpers would suppress one of them on account of a transitional form in *Ogygia.* The absurdity of suppressing groups on account of transitional forms is shown in the case of large and plastic assemblages where the more categories are needed the more they are suppressed.

Generic determinations should be made by comparing each species with the type of the genus. If a species differs in structure from this type, the determination is probably erroneous. A species may be referred to a given genus on account of its resemblance to the type or in spite of its differences. Often the type of the genus has never been ascertained and determinations are made by comparing with species which have been referred to it without any careful examination.

As a criterion for erroneous generic determinations, about all that can be done is to base inferences upon what the history of nomenclature shows. Accordingly we may take it for granted that genera will be subdivided in the future as in the past. Large genera in orders which have been neglected will be subdivided so that they will contain as many species as in orders which have been more thoroughly studied.

Smith's catalogue of the insects of New Jersey, the catalogue of the hymenoptera of Connecticut, local insects taken on flowers and the entomophilous flowers on which they were taken show the following averages of the spe-

cies for each genus. The genera of bees given in the New Jersey and Connecticut lists are those recognized by Viereck, but his views correspond with, and were probably somewhat determined by those of Cockerell, Crawford, Swenk, Sladen, Lovell and Ellis. While these authors might have different views in a few cases, the difference would hardly affect the averages.

	Species	Genera	Average
New Jersey, 1910:			
Hemiptera	504	205	2.4
Lepidoptera	2,120	715	2.9
Coleoptera	3,092	1,079	2.8
Diptera	1,661	542	3.0
Non-aculeate Hym	1,078	408	2.6
Lower Aculeata	452	99	4.5
Total	8,907	3,048	2.6
Bees	250	34	7.3
Genera suppressed		18	4.8
Connecticut, 1916:			
Non-aculeate Hym	1,819	481	3.7
Lower Aculeata	361	118	3.0
Total	2,180	599	3.6
Bees	231	35	6.6
Genera suppressed		31	3.5
Carlinville:			
Hemiptera	21	18	1.1
Lepidoptera	95	71	1.3
Coleoptera	137	82	1.6
Plants	437	261	1.6
Diptera	403	234	1.7
Non-aculeate Hym	126	74	1.7
Lower Aculeata	209	84	2.4
Total	1,428	824	1.7
Bees, R., 1918	296	98	3.0
Ashmead, 1899	296	50	5.9
Cockerell, 1918	296	45	6.5
Cresson, 1887	296	38	7.7
Dalla Torre, 1896	296	32	9.2

The table shows that, as regards genera, the lower aculeate hymenoptera and the bees have been neglected. Even 98 genera are conservative. On the analogy of the 1,428 species of other groups the 296 local bees should be referred to about 174 genera. The 250 New Jersey bees ought to be referred to about 96 genera, and the 231 Connecticut bees to 88 genera.

From the table we may presume also that when the number of species to the genus averages more than 1.7 for a locality like Carlinville, or more than 2.6 for a region like New Jersey, the generic determinations are erroneous. The table also establishes the presumption that the genera of bees suppressed in the New Jersey and Connecticut lists were suppressed erroneously. If the genera mentioned and suppressed in the two lists were used the average would be 4.8 for New Jersey and 3.5 for Connecticut.

To avoid the conclusion that these generic determinations are erroneous it is necessary to show that the genera in the other groups are not correctly determined, or that the bees differ from all of the other groups in a lack of characters on which generic distinctions can be based.

Charles Robertson
Carlinville, Illinois

THE NECESSITY FOR BETTER BOOK AND NEWSPAPER MANUFACTURE WITH RESPECT TO MATERIALS USED

Owing to the effects of the present war many of our productions have suffered greatly in quality. Manufactures of all kinds that, five years ago, were as fine in all particulars as the world has ever seen turned out anywhere, have now depreciated to such an extent, in proportions and quality, that one would hardly believe, without due comparison, what an enormous falling off there has been in many instances. It has affected the output of nearly every one of our best industries, with possibly the exception of the manufacture of war munitions, war materials, and some others too well known to mention. There are thousands of newspapers published in this country. Some of the wealthier ones do not seem to have suffered much, while in the case of the majority of the smaller sheets, they have not only shrunk in the matter of their size and number of pages, but the materials used in their manufacture, notably the paper and ink, are so poor in quality that the paper, in an incredibly short space of time, becomes more or less brittle, yellow, and blotchy, all of which are but premonitory symptoms of a crumbling away—a condition that proceeds

pari passu with a fading of the ink used in printing which was, initially, of a very indifferent quality in all respects.

Now, if we take the best newspapers of the country as a whole, it goes without saying that they do and will carry the great bulk of reliable contemporary history of this war. They obtain their war news direct from a dozen or more of the very best and most reliable sources; and while they may make errors on any particular day with respect to such news, those errors are invariably corrected, in the same media, usually within short periods afterwards.

A surprisingly large number of our newspapers are now printed on the very worst paper imaginable and with inks that fade and blunt the type. All this makes for the prompt and permanent destruction of current history, and especially of the military history of the war.

So much for the newspapers; but that is not the worst of it, for what applies to newspapers is equally pertinent with respect to book and current literature generally. Books of the greatest possible value representing the literature of every department of science and research, of history and current fiction, and many other lines, are now being printed with blunt type on the most perishable kinds of wood paper, and bound in such ways that they go to pieces in an incredibly short space of time. This stricture not only applies to what is being done along such lines in this country, but likewise by most of the nations that are doing any publishing in Europe.

In other words, we are not making books on standard or any other kind of literature nearly as good, in so far as their lasting qualities are concerned, as they did in the fourteenth and fifteenth centuries. This fact I recently touched upon in an article I published in the *Medical Review of Reviews* of New York City, on the "Incunabula in the Library of the Army Medical Museum of the Surgeon General's Office." Few studies in books are more interesting than to make such comparisons as these; take some of the best volumes for instance published in 1450 and compare them with any of the best works in contemporary science and mark the difference.

It is truly marvelous to note the general quality of the work they put out in those early days—now nearly five hundred years ago. To be sure the illustrations are generally crude, while the binding, paper and printing are far and away ahead of fully fifty per cent. of the same kind of output of the present time.

No one of my present acquaintance is more familiar with all these matters than Mr. Felix Neumann, of the Library of the Surgeon General's Office, and he has, a few days ago, been so good as to submit me the following notes on the subject which have never been used in any other connection heretofore. Mr. Neumann points out that:

Periodicals and newspapers, the latter very important sources of contemporary history, are printed on such poor paper that it is very doubtful how long they will last and how long they can be preserved in libraries. In some libraries they are kept, as a matter of protection, in an entirely dry room and not loaned for use in private residences. As these periodicals and newspapers are of the greatest importance, it is desirable that those copies to be deposited in libraries should be printed on special and more durable paper. In England, for instance, there exists a law issued in the seventeenth century that the copies designated for the library of the king and for the libraries of Cambridge and Oxford, should be printed "on the best and largest paper."

An indifferent paper had already been in use at different periods. For instance, in the first half of the seventeenth century, during the Thirty Years War, the durability was not to be blamed so much as the poor quality of the paper. Many of the books printed during this period were printed on a brown paper. Such matters became still worse in the seventies of the last century, at which time many publications were printed on paper made from wood-pulp which at that time came into vogue. In consequence of this indifferent manufacture many books and bound volumes of scientific periodicals had to be reprinted by an anastatic process, as the originals had fallen to pieces.

The deterioration of printed paper of poor quality depends greatly on the influence exerted by light and heat, although paper of better quality suffers sometimes from the same reasons. Taking all this into consideration, it is advisable that the government should supervise the examination of all

paper, or that the Bureau of Standards should serve to the same end. Our technical institutions and colleges should also pay more attention to the manufacturing of paper and should add to their curriculum the manufacture of paper and lectures on the paper industry.

But far more important is it that publishers and libraries and learned institutions should work together in such matters to the end that all publications, books as well as periodicals, to be used and preserved by such institutions, should be printed on paper of good lasting quality. Such publications must have printed on their title-pages the words, "For Library Use." To be sure, publishers will charge more for such copies than for the ordinary ones. The libraries and learned institutions will gladly agree to this. The same would apply to certain newspapers.

I must believe that what has been pointed out above will be sufficient to invite attention to this most important question; and as the space in these columns is of unusual value its consideration will not be further touched at this time.

ROBERT WILSON SHUFELDT

ARMY MEDICAL MUSEUM

THE CANONS OF COMPARATIVE ANATOMY

IN the discussion in this journal[1] of the so-called canons of comparative antaomy as illustrated in the vessels of angiosperms and *Gnetales,* Professor E. C. Jeffrey employs his canons (!) in the familiar methods of the believers in *schrecklichkeit.* As such methods in any field of activity have very little effect on the real issues, the writer declines to be drawn into tempting retaliations or into discussions of unnecessary side issues apparently intended as diversions, but proposes to end the matter, so far as he is concerned, with a simple summary of the facts and the conclusions which have been drawn from them on both sides.

1. Two of the canons (recapitulation and conservatism in certain regions) are beautifully illustrated in connection with the vessels in question. In regard to this statement Professor Jeffrey and I are in entire agreement.

[1] SCIENCE, N. S., Vol. XLVII., Nos. 1214, 1221 and 1231.

2. The porous perforation of the vessel of *Gnetum* has been evolved by the enlargement and coalescence of circular, haphazardly-arranged perforations (*Ephedra* type) which are themselves in turn derived from typical bordered pits. In regard to this statement also Professor Jeffrey and I are apparently in entire agreement; at any rate our disagreement is not based on it.

3. The similar porous perforation of the vessel of higher angiosperms has been evolved by the disappearance of the bars from the perforations of the scalariform type found in lower angiosperms. With this statement Professor Jeffrey was in entire agreement when his very recent and excellent book "The Anatomy of Woody Plants" was written. On page 379 of that work he wrote, "The vessel with the porous type of perforation is clearly derived, as has been demonstrated in an earlier chapter, from the scalariform condition." (See also pages 101 and 102.) In his latest contribution to this discussion he states, however, that in some cases it originates as described in statement (2) for *Gnetum.* Nevertheless, inasmuch as he gives no instances of this phenomenon in angiosperms, and does not even mention it in his book, we may conclude that statement (3), which is merely another way of expressing his own quoted statement, is essentially correct.

4. From (2) and (3) it follows that the porous vessels of angiosperms and *Gnetales,* though similar, have been evolved in entirely different ways and therefore have no genetic connection. They can not, therefore, be used as evidence of relationship between these two great groups of plants. From this statement Professor Jeffrey dissents, apparently believing that it is not a legitimate inference from the given premises. To the writer it appears to be the only logical inference.

W. P. THOMPSON

QUOTATIONS

THE COORDINATION OF SCIENTIFIC PUBLICATION IN GREAT BRITAIN

THE Faraday Society arranged a meeting to consider the "Coordination of Scientific Pub-

lication" on May 7 last. The discussion was opened by Sir Robert Hadfield, President of the Society and a member of the Subcommittee appointed by the Conjoint Board of Scientific Societies to deal with the "Overlapping between Scientific Societies." Among others who spoke were Professor Schuster, Dr. R. Mond, Mr. Longridge (president of the Institute of Mechanical Engineers) and Mr. Wordingham (president of the Institute of Electrical Engineers). Sir Robert Hadfield's chief suggestion was that there should be a Central Board (such as the Conjoint Board) appointed to receive all scientific papers and to allot them for reading and discussion to the society to which they would be of most interest. In addition the board should circularize other societies likely to be interested in order that their members might be aware of what had been done and enabled to attend and take part in the discussion if they so desired. This plan would, of course, involve some degree of federation between all the larger societies; a federation which was evidently regarded very favorably by those present at the meeting. It has indeed already taken place in Germany, where a Union of Technical and Scientific Societies, with a roll of some 60,000 members, has been formed more especially to cope to the best advantage with the problems which must arise at the end of the war. In New York also the United Engineering Societies have a central building and library, provided by the generosity of Andrew Carnegie, where the several societies meet for discussions, and where they are brought into closer contact than is possible with the decentralization which obtains here. Nor should the federation be limited to the United Kingdom alone. The great societies should have Colonial representatives, particularly those dealing with problems of an industrial character. In pre-war days the Iron and Steel Institute had a representative of the German Empire, which was thus kept in touch with English research, but no representative from our own Dominions. With a federation of this kind it might be possible to maintain a common building (*e. g.*, an enlarged Burlington House) for meetings and to house a joint library which should contain, in particular, all the publications referred to in the International Catalogue. Several speakers dilated on this idea, Dr. Mond suggesting that it should have a staff of translators competent to provide complete translations of papers written in the more difficult languages (*e. g.*, Russian or Japanese) when they were required; while Mr. Longridge went further in desiring a College of Librarians; men able to discuss research with inquirers and not merely to put them on the track of past work, but also to inform them of the work then in actual progress! Less utopian was the demand for uniformity in publication. It is most desirable that all Proceedings, Transactions, etc., should be printed on the same sized paper and in the same type so that collected papers on any one subject may be bound together. The scheme for the pooling of papers was opposed by the institutions on the ground that they awarded prizes for the best papers submitted to them and that, under the scheme, this incentive to research might disappear. Obviously, however, this difficulty might easily be overcome if each society retained the right to print any papers sent to them irrespective of their ultimate fate at the hands of the board. A more serious objection is that a paper is usually written for a particular class of reader. A treatment suitable for the Physical Society would probably not be best for the Iron and Steel Institute. Having regard to this fact it seems probable that a central board would find its most important function in issuing a weekly or monthly list of forthcoming papers with intelligible abstracts, as suggested by Professor Schuster.—*Science Progress.*

SCIENTIFIC BOOKS

Dynamic Psychology. By ROBERT SESSIONS WOODWORTH. New York, Columbia University Press. 1918. Pp. 210.

A critic in the *Nation* once remarked, "When a statement is obviously false we call it stimulating; when it has no meaning what-

ever we call it suggestive." The present reviewer has long cherished this saying as profoundly apposite, but occasionally one encounters a thinker who can be both sane and stimulating, at once clear and suggestive. That Professor Woodworth is such a thinker is perhaps more apparent than ever before in this little volume containing his Jesup lectures. Withal it has great charm of style.

Professor Woodworth's conception of dynamic psychology is that, maintaining friendly relations with both behaviorism and the introspective school, it treats experience from the causal rather than the merely descriptive point of view. Its problem is twofold, that of *drive* and that of *mechanism*; of the impelling forces behind various forms of experience and of the method by which these forces operate. From this general point of view the several lectures, after an introductory discussion of "The Modern Movement in Psychology," deal with the topics of "Native Equipment," "Acquired Equipment," "Selection and Control," "Originality" and with abnormal and social behavior.

The characteristic feature of the author's conception of mental dynamics is that the various nervous mechanisms for the performance of mental function are not apparatus waiting to be filled with energy from a few great drives or instincts; that, on the contrary, every mechanism has a drive of its own. The mere fact of its existence as an adequate mechanism means that there is a special tendency to use it. He takes issue with McDougall on this point. Special interests and aptitudes, for instance, are not, Woodworth thinks, based on nervous mechanisms that are driven solely by great general impelling forces called interest, pugnacity, and the like; the motive forces are inherent in the mechanisms themselves and are impelling interests for their own special objects.

A drive, according to him, involves the advance excitation of the final or consummatory reaction of a series: this incipient reaction sets into operation all the associated movements which tend to bring it fully about. A mechanism which thus possesses its own drive must be an innately good mechanism; thus the "interest" which impels the student of music is due to the fact that his musical mechanisms, by innate endowment, work well.

The author is thus led logically to take issue with Freud. The various creative activities which the latter refers to the redirected energy of the sex instinct as their sole driving force, have in Professor Woodworth's opinion driving forces of their own. Of "sublimation" he writes that when an intellectual interest, say, is made to supplant the sex impulse, the latter "is not drawn into service, but is resisted." It is true that a drive may enlist other mechanisms into its service, but these are "mechanisms that subserve the main tendency, whereas 'sublimation' would mean that the tendency towards a certain consummation would be made to drive mechanisms irrelevant or even contrary to itself. There seems to be really no evidence for this, and it probably is to be regarded as a distinctly wrong reading of the facts of motivation." Professor Woodworth's idea that only inherently good mechanisms possess drives of their own is also in curious contrast to the perverse view of Adler, whom he does not mention; the view, namely, that special interests are due to inferiority of the organic mechanisms involved.

It is a refreshing doctrine that makes our intellectual interests thus self-supporting and independent of the great impelling forces which we share with the lower animals. Whether it can be carried as far as the author carries it without departing from probability the reviewer is inclined to doubt. The advantage of the opposed conception, which appeals solely to the primitive drives, is that we can see a biological justification for activities thus motivated. We can understand why organisms that failed to be driven by sex, pugnacity, gregariousness, must have been eliminated in the struggle for existence; it is not easy to see why an individual who failed to exercise for its own sake a nervous mechanism for music or mathematics should have been biologically unfit. Again, as Professor Woodworth points out, although a nervous

mechanism that works well supplies its own drive, it must not work too well; there must be some stimulus of difficulty. But may it not be argued that when a person loses interest in his work because his task is too easy, his mechanism too good, the reason must be either that the consummatory reaction is not connected with one of the great biological drives, or that he is not the kind of person to whom unsolved problems, that is, mechanisms some of whose parts are still undetermined, are *ipso facto* very strong drives; one who turns always from the familiar to the new task? If he is of this type we may as well say that he is urged by the drive of curiosity, whose biological value is clear. In other words, while special talents, specially good mechanisms, may involve special readiness of their consummatory reactions to be excited, without certain general traits of the personality like energy, curiosity, pugnacity, mere excellence of a mechanism would not suffice for its prolonged and effective use. The reviewer has elsewhere pointed out the possible function of the activity attitude in connection with those intellectual tasks which are only indirectly related to the primitive drives.

Of the many other points for discussion that are suggested by these lectures, there is space to mention but one. Those of us who hold, with the author, that introspection has furnished some scientific results "with such regularity that they command general assent, and probably even the extreme behaviorists in their hearts believe them," will be interested to observe how much of the evidence for Professor Woodworth's contentions is of an introspective character. In his arguments on the nature of human motivation the appeal is constantly to introspection.

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A Laboratory Outline of Neurology. By C. JUDSON HERRICK and ELIZABETH C. CROSBY. Philadelphia and London, W. B. Saunders Company. 8 vo. 120 pp.

After many years of teaching experience on the part of the senior author, C. J. Herrick and E. C. Crosby have produced an excellent laboratory outline of neurology. The outline includes directions for the dissection of the brains of elasmobranchs and of mammals. The directions for the elasmobranchs are especially acceptable for they are accompanied by some much needed and novel diagrams from the unpublished work of Norris and Hughes. In addition to a very clear and well-arranged account of the subject matter, the volume contains abundant references to the literature. The text is arranged so that it may serve for a variety of courses, seven of which are outlined in the introductory chapter. The volume is compact and well printed both as to text and illustrations.

G. H. P.

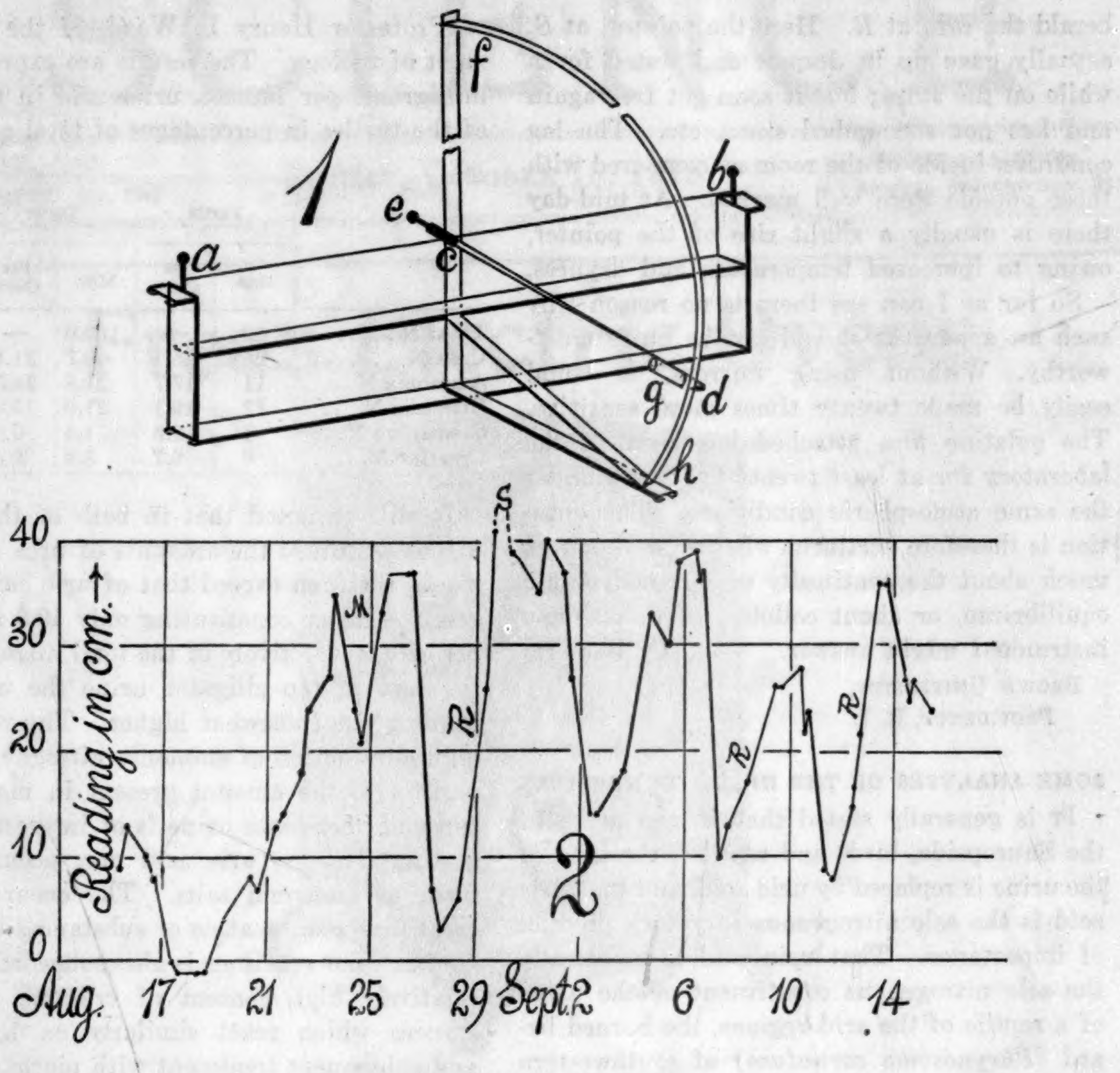
SPECIAL ARTICLES

HYGROMETRY IN TERMS OF THE WEIGHT OF A FILM OF GELATINE

I HAVE recently had occassion to reconstruct a form of horizontal torsion balance which I used in 1890 in measuring the absolute viscosity of steel.[1] Even when quite robust, it can easily be made so sensitive that an excursion of over 10 cm. is equivalent to a milligram. It should therefore be available for indicating the absorption of atmospheric vapors on the part of light bodies.

Fig. 1 shows the apparatus, the suitably braced frame being made of strips of tin plate, bent C-shaped in cross section to secure rigidity. The torsion fiber, *ab*, of brass wire, .2 mm. in diameter 35 cm. long, is stretched between vertical screws (around which the end are wound), each provided with a lock nut so that a fixed tension may be imparted to the wire. The pointer, *cd*, also about 35 cm. long and of light varnished wood, is carried at the middle of the tense wire (threaded through a fine hole in the stem and looped around it), with an adjustable screw counterpoise at *e* in the rear. The index at, *d*, plays over a light circular scale of brass, *fh*, which in my apparatus comprehended about 130°, though it

[1] *Phil. Mag.*, XXIX., p. 344, 1890. The change of the electrical resistance of gelatine in relation to hygrometry has been studied by Dr. G. B. Obear.



would be much better to make it 180° from the ends of a vertical diameter. The film of gelatine (conveniently bent in form of an open cylinder and fastened with a little wax) is shown at *g*. The mantel contained about 3×13 sq. cm, of area and the film was less than .1 mm. thick, weighing about .4 gram.

As the observations contained in Fig. 2 are tentative, I merely chalked a centimeter scale increasing downward on the strip *fg*, to specify the position of the index. If absolute data were to be reached, the scale would, of course, have to be graduated in terms of $(\theta_0 - \theta)$ sec θ where θ is the variable angle measured in a given direction from the horizontal diameter of *fh*; or a torsion head could be provided at *b*. Fig. 2, in which the position of the pointer *d*, on successive days are laid off vertically, the curve rising as the weight of the gelatine increases, is sufficiently interesting without this and I merely placed the apparatus (without a case), in a quiet corner free from draft and read off the centimeters from across the room. It is in fact fascinating to watch it from day to day; for the play of the pointer, in spite of the handicap of leaverage, is over 40 cm. along the strip. The lowest position occurred during the relatively cool weather following August 15. After that the weight increased until the very muggy weather at *M* toward August 25 was passed through. With the arrival of a cold wave the weight drops almost suddenly, to increase again with equal abruptness to

herald the rain at *R*. Here the pointer, at *S*, actually gave up in despair and rested for a while on the stops; but it soon got free again and has not succumbed since, etc. The lag condition inside of the room as compared with those outside were well marked. At mid-day there is usually a slight rise of the pointer, owing to increased temperature and dryness.

So far as I can see there is no reason why such an apparatus should not be quite trustworthy. Without using mirrors, it could easily be made twenty times more sensitive. The gelatine film attached has been in the laboratory for at least twenty-five years under the same atmospheric conditions. The question is therefore pertinent whether we know as much about the continuity of thermodynamic equilibrium, or about colloids, as this simple instrument might answer.

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SOME ANALYSES OF THE URINE OF REPTILES

It is generally stated that in the urine of the Sauropsida, birds and reptiles, the urea of the urine is replaced by uric acid, and that uric acid is the sole nitrogenous excretory product of importance. That uric acid is practically the sole nitrogenous constituent of the urine of a reptile of the arid regions, the horned lizard (*Phrynosoma cornutum*) of southwestern United States has been recently shown by the analyses of Weese[1] from this laboratory. Examination of the urines of some aquatic or semi-aquatic reptiles has indicated that uric acid is of less importance quantitatively in the urine of reptiles of this type than is generally assumed.

The urine was removed from the urinary bladder immediately after the death of the animal by bleeding, and analyzed promptly. The use of the newer analytical methods (colorimetric determination of uric acid and creatinine (urease determination of urea) made possible the accurate analysis of small volumes of dilute urine. The specimen of alligator urine was obtained through the courtesy of Professor Henry B. Ward, of the department of zoology. The results are expressed as milligrams per 100 c.c. urine and in the case of the turtles in percentages of total nitrogen.

	Turtle		Turtle		Alligator
	Mgs.	Per Cent.	Mgs.	Per Cent.	Mgs.
Total N	62	—	150.0	—	—
Urea N	28	45.1	46.7	31.1	29
Ammonia N	11	17.7	21.8	14.5	44
Uric acid N	12	19.1	21.0	14.0	47
Creatinine N	1	1.6	1.4	0.9	—
Creatine N	6	9.7	3.9	2.6	—

It will be noted that in both of the turtle urines examined the amounts of urea and ammonia nitrogen exceed that of uric acid nitrogen, the latter constituting only 19.3 and 14.0 per cent. respectively of the total nitrogen. In the case of the alligator urine the uric acid content was somewhat higher. The relatively high elimination of ammonia nitrogen in comparison to the amount present in most other types of vertebrate urine is of interest in suggesting that the uric acid may occur in the form of ammonia salts. The occurrence of creatinine and creatine or substances that give similar color reactions is also noteworthy. The relatively high content of creatine (or substances which react similarly on hydrolysis and subsequent treatment with picric acid and alkali) was confirmed by determinations by both the Folin-micro and S. R. Benedict methods.

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[1] Weese, A. O., Science, N. S., Vol. XLVI., No. 1195, p. 517, 1917.

SCIENCE

A Weekly Journal devoted to the Advancement of Science, publishing the official notices and proceedings of the American Association for the Advancement of Science

Published every Friday by

THE SCIENCE PRESS

LANCASTER, PA. GARRISON, N. Y.
NEW YORK, N. Y.

Entered in the post-office at Lancaster, Pa., as second class matter